Hist. Part / Cat. / 3

UNIVERSITY OF CAMBRIDGE

HISTORY OF SCIENCE LECTURES COMMITTEE

AN EXHIBITION OF HISTORIC SCIENTIFIC INSTRUMENTS AND BOOKS

in the

EAST ROOM OF THE OLD SCHOOLS

4–11 NOVEMBER 1944

The Exhibition will be opened by
SIR HENRY DALE, O.M., G.B.E.
PRESIDENT OF THE ROYAL SOCIETY
on Saturday, 4 November, at 2.45 p.m.

The Exhibits are drawn from the Collection which MR R. S. WHIPPLE is presenting to the University and will form a nucleus for a History of Science Museum and Library in Cambridge.

INSTRUMENT & APPARATUS
FE51
CAMBRIDGE : History of Science,
Museums
H- of SC - ; M- : Great Britain

FOREWORD

By THE VICE-CHANCELLOR

The Whipple Collection of Historic Scientific Instruments and Books, a representative portion of which is displayed in this Exhibition, is the generous Gift to the University of one who is himself an eminent instrument maker—and what is perhaps of even greater significance and interest to us—an eminent Cambridge instrument maker. There can hardly be any laboratory or department of Science in the University that does not possess some instrument of precision fashioned under his direction. But we are fortunate also to be able to profit by his pursuit, for more than thirty years, of a hobby closely linked to his life's work. His Collection contains examples of fine craftsmanship from those centres in all countries where Science flourished for nearly four centuries. Our forefathers certainly did not disdain to apply their highest art in the production of their precision tools for the investigation of Nature. Let us hope that the study of their work will inspire our scientists of the future (no less than our historians) to give serious thought to what they owe to the past and that, in so doing, they will recapture some of the fun that went to the making of this Collection. The University owes Mr Whipple a debt of gratitude for his Gift and it will interest visitors to the Exhibition to know that he has been personally responsible for preparing the catalogue and arranging the exhibits.

T. S. HELE

26 *October* 1944

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INTRODUCTION

THE earliest scientific instruments were designed and used by astronomers. It is thought that Greek astronomers in Alexandria were the first to determine the position of stars by systematic observation made with instruments.

The Astrolabe, the most used of all early instruments, is based on that said to have been invented by Hipparchus about 150 B.C. The instrument, as we know it, was probably developed by the Arabs and became a tool of considerable precision. By its means, time and latitude could be determined.

The first English text-book on scientific instruments was by Chaucer, entitled *Treatise on the Astrolabe*, 1391, and, as R. T. Gunther remarked, "a treatise which, after five hundred years, is still the standard work on the subject in our language".*

The Astrolabe, and later the Cross-staff, were used in navigation until the invention by Davis of his Back-staff, about 1540, which avoided the necessity of looking directly at the sun. The Octant, invented by John Hadley in 1731, is still, in the form of the Sextant, the most important instrument the sailor possesses, although wireless and other modern navigational aids are gradually removing it from its position of pre-eminence.

The Astrolabe also formed the basis of the original Theodolite, the name *Theodolitus* being given to it by Thomas Digges in describing his father's invention previously to 1571. The addition of a telescope to the simple surveying instrument, in place of the sights used by the unaided eye, marked a great advance in the accuracy of surveying.

The invention of the Telescope enabled Galileo to make the researches with which his name will always be associated. In 1610 he discovered the satellites of Jupiter with a telescope of his own manufacture. It is said that he made hundreds of telescopes with his own hands.

Sir Isaac Newton made the essential parts of his reflecting telescope, casting and polishing the speculum with his own hands, about 1671. This instrument is now one of the greatest treasures in the possession of the Royal Society. In 1733 Chester Moor Hall, an amateur, found that by combining lenses made from glasses having different refractive indices, he was able to correct for the unequal refrangibility of light of different wave lengths, and suc-

* *Early Science in Oxford*, Vol. II, p. 203.

ceeded in making lenses which produced images free from colour. This great discovery remained unknown until 1756, when John Dollond independently invented and produced an achromatic telescope in which the object glass consisted of a convex lens of crown glass combined with a concave lens of flint glass. The reflecting telescope was greatly developed by Sir William Herschel (1738–1822). Owing to the kindness of the late Howard Marryat a very complete example of one of Herschel's instruments is included in the Exhibition.

It is to Robert Hooke, a contemporary of Newton, that we owe the first description in English of a compound Microscope, which in many ways is similar to the modern instrument. The *Micrographia*, published in 1665, gives a full description of this model and shows that Hooke had given much thought to its design, construction and use. Marshall, about 1693, introduced his microscope "for Viewing the Circulation of the Blood", which was an improvement on that of Hooke. The support carrying the body of the microscope was mounted on a ball-and-socket joint, so that the inclination of the instrument could be varied. A fine adjustment focusing screw, a moveable stage, and a condensing lens were also fitted; all of these later improvements are incorporated in the modern instrument.

In the meantime Leeuwenhoek of Delft (1632–1723) designed and made a simple form of single-lens microscope of short focus with which he made some remarkable discoveries. He gave the first accurate description of the red blood corpuscles, and in 1683 first published a representation of bacteria in the *Philosophical Transactions of the Royal Society*.

The simple microscope was further developed by a distinguished Dutch instrument maker, Van Musschenbroek (1660–1707). In England the screw-barrel microscope, generally bearing the name of Wilson and first described by him in 1702, became very popular and there are many models in existence, some of them made of ivory and having a selection of lenses of various powers. These instruments were often fitted on ingenious stands, as the need for a support was felt.

An elegant form of instrument was designed by G. Lindsay, but was not very practical; it is of interest as being the first microscope patented (1742); the example shown in the Exhibition is made of silver. The Culpepper microscope, invented about 1730, was a great step forward in introducing a rigid instrument which was comparatively easy to make and use. The development of this form of three-pillar microscope is illustrated in the Exhibition. J. Cuff, influenced by the design of the Marshall microscope, introduced in 1744 the model with the comparatively heavy stand and this, with modifications by various makers, was very popular.

Benjamin Martin (1714–1782) was a maker who had great influence on the development of optical instruments. He appears to have invented the drum microscope and was the first to fit a micrometer to a microscope. He supplied cabinets of instruments which were examples of excellent workmanship. He also wrote several books on popular science.

George Adams the elder (1710–1773) was established as an instrument maker at the Tycho Brahe's Head in Fleet Street in 1735 and he, and his son, who followed him, had great influence on the development of the microscope, and indeed, on the majority of instruments used for scientific work at that time. His book *Micrographia Illustrata*, 1746, was in much demand, passing through four editions. He made many of the instruments which formed the George III collection and which are now in the Science Museum at South Kensington.

The microscope was further developed by other makers, both British and foreign, the British microscope in the early nineteenth century being distinguished for its superior workmanship. The development of the achromatic objective by Chevalier of Paris in 1824 was a great advance in the development of the microscope. Chevalier also improved many of the details of the instrument.

The Exhibition contains a selection of Microtomes showing the development of the rocking microtome by Horace Darwin from the original microtome (not exhibited) designed by Caldwell and Threlfall in 1881.

The astrolabe was mentioned at the commencement of this note as being the earliest scientific instrument for the measurement of time. In saying this it must not be forgotten that the sun-dial has been used from the earliest times. Before the watch was developed much thought had been devoted to the design and manufacture of sun-dials for the accurate determination of time and also for portability. A large variety of these instruments are exhibited, many of them specimens of beautiful workmanship.

In looking at the majority of instruments made by the old makers, for whatever purpose they were intended, one is impressed with the high quality of their workmanship.

Mutual co-operation between the scientist and the scientific instrument maker is essential: a study of the achievements of their predecessors should inspire them both to better work.

R. S. WHIPPLE

CATALOGUE

Owing to lack of time it has not been found possible to catalogue the exhibits as fully as would have been wished. As far as possible, similar instruments have been placed together and descriptive labels attached.

ASTRONOMICAL INSTRUMENTS

ASTROLABES.

Six examples are shown.

German Astrolabe. 4 in. diam., dated 1597. An excellent example of early workmanship.

Arabian Astrolabe. 5 in. diam., fitted with four latitude plates or tablets. *c.* 1800.

Combined Astrolabe, Quadrant and Universal Sundial. With Compass, marked "Tobias Boekmer, 1645".

NOCTURNALS.

(By means of which time is determined from the Pointers of the Great Bear or the "Bright" star of the Little Bear.)

German Nocturnal. Gilded brass. *c.* 1600.

English Nocturnal. In wood. *c.* 1700.

German Nocturnal. Gilded brass for use with Sirius. It belonged to Caesar Sambara, Bishop of Tortona; his coat-of-arms and the initials "C. T." are engraved upon it. He held the Bishopric in 1548.

Combined Nocturnal and Quadrant. $2\frac{1}{2}$ in. diam., with plumb-bob and sight, dated 1531.

Combined Nocturnal and Quadrant. Marked "Faict à Sens par Vincent Bonneau 1574".

Ring Dials, *c.* 1600–1850. A selection of Ring Dials, varying in diameter from $2\frac{3}{4}$ in. to $12\frac{1}{2}$ in. The largest dial made by Heath and Wing, *c.* 1770, is of interest; the time scale is divided into minutes. The one in silver is by Lasnier, Paris. The dial made by Negretti and Zambra, is said to have belonged to Brunel, the distinguished engineer (1806–1859).

Poke Dials. So called because in *As You Like It* (Act II, Scene 7) Jaques explains that the fool "drew a dial from his poke, and, looking on it with lack-lustre eye, says very wisely, 'It is ten o'clock'".

Dial. Simple model, British, most probably the type to which Jaques referred.

Dial. British, with adjustments for latitudes 45°–49°.

Dial. German, gilded, with silver time scale and with adjustment for latitude. *c.* 1700.

Dial. French, silver. Marked "Juan Beiquin à Bordeaux", in snake-skin case—an example of beautiful workmanship. *c.* 1650.

Multi-gnomon dials, *c.* 1700. A number are exhibited. The one in ivory and silver (French) is worthy of notice.

Mounted Universal Dials. (Called "Universal" because they could be used in any latitude.) A large selection of these is exhibited. The following are of interest:

Dial. 4 in. radius, richly engraved and evidently made for a foreign customer. Marked "Faite par J. Rowley—Maitre des Mecaniques du Roy". *c.* 1700. It will be noticed that the time readings are shown on a clock dial.

Dial. Italian, gilded. Marked "Micheli Bertini 1780". The mechanism for altering the position of the diaphragm for the time of the year is of interest.

Dial. German, with plummet and level. Marked "J. B. Schmidt in Wien". *c.* 1700.

Portable Universal Dials. The English dials were characterised by robust workmanship, but were rarely decorated. The selection includes examples by G. Adams, father and son, Dollond, W. and S. Jones, Pedrone, and Troughton and Simms (*c.* 1750–1850). A dial (exhibited) made by Adams is known to have been the property of Warren Hastings. Several dials of German manufacture are exhibited: some of these are richly decorated. Special attention may be drawn to two dials, in which semi-circular scales are mounted on the East and West sides of the meridian line. The small instrument is marked "Johan Martin in Augsburg, 48" (1648). The large one, probably by the same maker, is shown in a decorated leather case. Attention may be drawn to a silver dial by Andrew Vogler (*c.* 1700) in which the original instructions for using the instrument are still in the case.

The German makers (more particularly at Augsburg) appear to have made large numbers of inexpensive universal dials in different sizes. The French makers, in addition to making various kinds of universal dials, appear to have concentrated on one model, generally known as the "Butterfield" type. In this instrument the position of the gnomon is indicated by a bird's beak. Several examples of this type of dial are shown.

Book, or String dials. In these instruments the gnomon consists of a string stretched between two ivory, metal or wooden plates, which open out at right angles to each other. The majority of this type were of German manufacture. The ivory one in the form of a book, with silver fittings, dated 1670, and the one by Lienhart Miller, 1646, are of special interest.

Shepherds' Dials. The name was given to this form of dial because they were largely used by the shepherds in the Pyrenees. Special attention may be drawn to the silver dial marked "Christophorus Schissler fecit 79" (1579).

Floating Dials. In these dials the compass card carries a gnomon mounted upon it; thus the gnomon is automatically set north and south.

The "Ship dial", in which the position of the gnomon is varied by means of a slider on the mast and the "Card dial", or "Capuchin", are rare forms of dial.

Orreries. Three instruments are exhibited, the most complete being by George Adams. *c.* 1800.

Armillary Sphere. On brass stand, $8\frac{1}{2}$ in. diam. Marked "Fenig fecit". The sphere is supported by a figure of Atlas. *c.* 1700.

A pair of Planetaria, 6 in. diam., on brass stands: scales silvered.

(1) Ptolemaic, marked "Rd. Glynn fecit, Cheapside, London".

(2) Copernican, marked "R. Glynne fecit". *c.* 1730.

Globe. Silver engraved globe, $3\frac{3}{4}$ in. in diam., of Italian workmanship. The Latin inscription placed in the mid-Atlantic infers that it was engraved by Paolo de Furlani who was a well-known engraver and vendor of maps in Venice in the second half of the sixteenth century. With snake-skin case.

Dipleidoscopes. The Dipleidoscope is a simple form of transit instrument designed by J. M. Bloxam about 1875. Several different models were made by E. D. Dent and Co. and the instrument is generally referred to as the Dent Dipleidoscope.

Portable Equatorial Theodolite, by G. Adams, London, with Azimuth Circle 6 in. diam. *c.* 1780.

REFLECTING TELESCOPES

Newtonian Telescope, with 8 in. Speculum mirror of 10 ft. focal length with a finder telescope and provided with a complete set of eye-pieces. Made by Sir William Herschel about 1800. It is said that George III presented this instrument to the Duke of Marlborough. It remained at Blenheim for over 100 years and was then given by the Seventh Duke to Mr J. A. Hardcastle. The instrument was presented to the present Collection for Cambridge by the late Mr Howard Marryat.

Gregorian Telescopes. A selection of these instruments is exhibited. Three with 4 in. mirrors made by Nairne, Francis Watkins and James Short. *c.* 1750. Gregorian Telescopes with smaller mirrors, the bodies being covered in snake skin or shagreen and intended for terrestrial work are included. In some small pocket instruments the stand fits into the body of the instrument.

REFRACTING TELESCOPES

Telescope. Vellum with eight draw tubes, probably made by Christopher Cocks the maker of Hooke's microscope. *c.* 1640.

Telescope. Vellum with one draw tube, probably made by Christopher Cocks. The decoration on this and the above instrument is similar to that on a named instrument in the South Kensington Museum, and the gold tooling to that on the Hooke microscope.

Telescope. With six vellum draw tubes by Leonardo Semitecolo. *c.* 1660.

Telescope. With wooden body and three brass draw tubes, marked "Altzschneider v. Fraunhofer in München".

A selection of telescopes with shagreen and silver, or brass, mountings, by Ayscough, Dollond, Mann, Martin, Nairne and Blunt, etc.

Telescope. Wooden body, 4 ft. long, with brass draw tube marked "James Mann".

Telescope. Shagreen and brass, o.g. 2 in. diam. with ten brass draw tubes marked "Adams, New Patent Portable Telescope, No. 60 Fleet Street, London". This is probably one of the earliest telescopes with several brass draw tubes.

Telescope. In tortoiseshell, with three silver draw tubes, by Nairne and Blunt, *c.* 1760.

Telescope. Cornelius Varley's Patent Graphic, with stand and case. This instrument was designed to enable artists to project the image of a landscape for reproduction. *c.* 1880.

MICROSCOPES

Microscope. Leeuwenhoek, *c.* 1670; model made from the instrument in the University Museum, Utrecht, by J. Mayall, *c.* 1885.

Microscope. The Hooke type with coarse focusing adjustment and protecting cap for holding spare objectives. The eye lens rests loosely in a concave cell. The leather covering and tooling is similar to that on the instrument in the South Kensington Museum and which is known to have belonged to Hooke. *c.* 1650.

Microscope. Musschenbroek type (perhaps a model). The method of rotating the diaphragms of varying aperture was first used on this instrument. *c.* 1700.

Microscope, Campani type. With vellum tube and leather case. Unfortunately the field lens and object glass are missing. *c.* 1700.

Microscope, Marshall type. This instrument, "John Marshall's New Invented Double Microscope, For Viewing the Circulation of the Blood", was introduced by him in 1704. It marks a great development from the original Hooke instrument. It is robust and is fitted with coarse and fine focusing adjustments. The support is mounted on a ball-and-socket joint so that the inclination of the tube can be varied.

Microscope, Culpepper type. A series of instruments by various makers showing the development of this type of microscope which was much in vogue in the eighteenth century. An instrument in which the eyepiece is fitted with a protecting cover containing four spare objectives is rare. *c.* 1700–1800.

Microscope, Cuff type. This instrument, described by the inventor in 1744, was a very practical model. The stage was more accessible than earlier models, while the focusing screw gave a fine movement. The accessories supplied were numerous and practical. Examples made by Adams, Blunt, Cuff, Dollond, Jones, Margas and Scatliff are shown. *c.* 1750–1800.

Amongst the foreign microscopes shown, the simple wood and vellum models may be noticed. They are generally referred to as the "Nuremberg type", as they were developed by the Nuremberg toy makers.

Microscope, New Universal Double. "Invented, made and sold by George Adams at Tycho Brahe's Head in Fleet Street, London," 1746. This instrument, of which Adams was very proud, is fitted with six lenses of different powers. The focusing screw is placed in the base of the instrument so that "the screw P. is to be turned as your hands and arms are resting upon the table". *From the Crisp Collection.*

Microscope of the "Jones most improved" type. In case complete with accessories, marked "Dollond, London". *c.* 1800.

Microscope, "Universal". Marked "Dellebarre, 1785". This make of microscope was very popular in France and was the subject of a special report to the Académie des Sciences in 1777.

Microscope, "Prince of Wales" type. Marked "Invented and made by Geo. Adams at Tycho Brahe's Head in Fleet Street, London". The method of mounting the microscope tube on trunnions is of interest; perhaps the first microscope so supported. It is provided with three stages, one being fitted with micrometer screws, registering in two directions at right angles to each other and reading to 1/10,000 in. *c.* 1760. Only one other example of this microscope is known—at the South Kensington Museum.

Microscope, Simple. Marked "George Lindsay, 1742". This microscope is made in silver and with regard to it J. Mayall states: "This miniature microscope is of two-fold interest to us: (1) it was the first microscope for which a patent was registered (1742); (2) the design is so neat and compact and so novel, and the workmanship so superior to the rivals of its day, that one has a difficulty in accepting the fact of its construction in 1742." *From the Crisp Collection.*

Microscope, Pocket. In silver, marked "J. Clarke, fecit Edin. 1756". Mounted on fish-skin box, with fine adjustment screw.

Microscope. Marked "Powell and Lealand, makers, London 1746". The support to the microscope tube should be noticed.

Microscope. By Cornelius Varley and marked "Varley Invent. London". The geometric mechanism for moving the stage is original. Only two other examples are known. *c.* 1860.

Microscope, Universal. This instrument was introduced by Chevalier (the first successful maker of an achromatic objective) as an instrument that could be used as a dissecting microscope as well as a high-power instrument. Three models are exhibited. *c.* 1830.

Microscope. This is fitted with a tubular stand and the focusing is varied by means of a chain mechanism. The slide is held in position on the stage by means of a magnetic grip. Probably made by Ladd. *c.* 1880.

Microscope, Amici, Reflecting. Complete in case marked "Amici, Modena" *c.* 1820. Owing to the difficulty of making achromatic objectives Amici and others developed the reflecting microscope with considerable success. *From the Crisp Collection.*

Microscope, Reflecting. Of the Amici form by Cuthbert of London. *c.* 1830.

Microscope. Marked "Andrew Pritchard, 162, Fleet Street, London". *c.* 1830.

Microscope, Binocular and Monocular. Marked "Andrew Ross", complete with accessories. *c.* 1870.

Microscope. Marked "Smith and Beck, 6, Colman Street, London", complete with accessories in separate box. *c.* 1870.

Microscopes, Chest. A selection of these instruments is shown, including examples by Nairne, Ramsden and other makers.

Microscope, Cabinet. Containing microscope with objectives and a Wilson screw-barrel microscope with fitting for converting the latter into a solar microscope, probably by Martin. *c.* 1740.

Microscope, Drum. This form of instrument, developed by Benjamin Martin about 1740, became very popular, especially on the continent. Examples by Adams and Martin are exhibited.

Microscopes, Wilson Screw-barrel. A selection of these instruments is exhibited. In some of them the tubes and fittings are made of ivory. The one fitted with leather pad, and not cork, was probably made by Wilson.

Microscopes, Dissecting and Pocket. A selection of these is shown.

Microscopes, Solar. Instruments by Adams, Martin and Watkin are exhibited. *c.* 1750–1800.

Microtomes. A group of microtomes shows the development of the Cambridge Rocking Microtome designed by Horace Darwin in 1885. It also shows the model of the Caldwell-Threlfall microtome as made by the Cambridge Scientific Instrument Company, *c.* 1884.

SURVEYING INSTRUMENTS

Quadrants. A variety of these instruments are exhibited. The following are of interest:

In brass, marked "Henr. Sutton fecit 1660".

In brass, engraved with landscape and marked "Hans Grebner". *c.* 1600.

In ivory, *c.* 1600.

Back-staffs. This instrument was invented by John Davis about 1540 for the observation of the sun's altitude at sea without the necessity of looking directly at the sun. Two instruments, *c.* 1700, are shown.

Octants. The back-staff was superseded by Hadley's Octant, *c.* 1730, the circular arc being originally one-eighth of the circumference of a circle. In one instrument the scale is read to minutes by means of a diagonal scale. The other instruments shown are provided with ivory scales and verniers.

Sextants. The large instrument (18 in. radius) by Dollond and the small one ($3\frac{1}{2}$ in. radius) in case, marked "C. E. Kraft, Wien", are of interest.

Circumferentors and Graphometers. A selection of these, mostly of French manufacture, is shown. Amongst the makers are Butterfield, Canivet and Sevin, 1700–1800.

Theodolites and Levels. The earliest instrument, in brass, is a simple form of astrolabe with divided circle and alidade. The large instrument marked "J. Sisson fecit 1770" and the two small ones by Ramsden and Watkins, *c.* 1750–1800, are of interest. An example of beautiful workmanship is shown in the 7 in. theodolite by Heath and Wing, *c.* 1800.

The level marked "Made by Tho. Wright, Instrument Maker to the Prince of Wales, 1724" is worthy of notice, both because of its workmanship and the fact that it was still in use in 1930.

Compasses. Amongst those shown, the Portuguese instrument dated 1711, and the boat compass in decorated leather case, *c.* 1700, should be noted.

MISCELLANEOUS OPTICAL INSTRUMENTS

Spy Glasses. Several of these are exhibited. Special attention is drawn to a glass by Dollond of tortoiseshell and silver with four variable-power eye lenses.

Spectacles. A variety of old spectacles, lorgnettes and reading glasses together with spectacle cases is shown. A cabinet of test glasses (eighteenth century) is included.

Zoetrope, or "wheel of life"—one of the earliest forms of moving pictures, with twenty-five pictures, *c.* 1850.

"Wheel of life." Two disks 12 in. diam., marked "Fores's Optical Illusions".

Magic Lantern. For use with two candles (without lenses). *c.* 1750.

Lantern Slides. Including various moving ones. Large slide used at the Polytechnic, Regent Street. *c.* 1880.

Kaleidoscope. In brass tube on stand, marked "R. B. Bate". *c.* 1850.

Stereoscope. With lenses, for opaque and transparent objects. *c.* 1870.

Stereoscope. With mirrors, for opaque objects. *c.* 1870.

Walking Stick. Containing telescope, spy glass, compass and microscope, marked "Copperdale and Co's Improved Patent, 25, Bride Lane, Fleet St, London". *c.* 1860.

Umbrella. Containing telescope, spy glass, microscope, thermometer and sun-dial. *c.* 1860.

Artificial Horizon. Circular black glass, 2 in. diam. mounted on levelling screws, in snake-skin case. *c.* 1800.

Ophthalmoscope. Miniature, with two lenses. *c.* 1800.

Concave Mirror. 6 in. diam. on stand. *c.* 1800.

MATHEMATICAL AND PHYSICAL INSTRUMENTS

Dynamical Top. Made of brass by Ramage of Aberdeen for Clerk Maxwell and exhibited by him in 1857, with Maxwell's paper describing the experiments with it.

Barometers. Examples by Nairne and Blunt, Benjamin Martin and J. Sisson. *c.* 1750–1800.

Bent Barometer. To give an expanded scale for the upper part of the range, by Thomas Page, Norwich. *c.* 1800.

Hydrometers. Two ivory, in wooden cases. *c.* 1800.

Lodestone. A natural magnet in brass frame with keeper, *c.* 1700.

"Box of Magnetical Apparatus." With bar magnets, dipping needle, compasses, etc., marked "G. Adams, Inventr. & Maker, London". *c.* 1790.

Pitch Pipe. Small organ pipe of variable length. *c.* 1800.

Napier's Bones. In ivory, complete set of twenty, in small wooden box. *c.* 1700.

Geometrical Solid Bodies. Box of, "Made by George Adams at Tycho Brahe's Head". Models in three dimensions illustrating Euclid's books XI and XII on solid geometry.

Calculator. Purpose unknown. Marked "Francisci de Padoanis, Foroliviensis" and "Erasmus Habermel, fecit 1580". *From the Strozzi Collection.*

Scales. A selection of rules (from 1648) in boxwood, brass and silver. The two-foot rules in brass and ivory, by Ramsden and Adams respectively, are of interest.

A selection of gauger's slide-rules, in wood, are exhibited, *c.* 1800.

Drawing Instruments. Several cases of instruments for use by artillery officers, etc. are shown. Attention is drawn to the complete set by R. Glynne, *c.* 1730, as an example of fine workmanship.

Architect's Scales to facilitate the drawing of the various orders of columns, Tuscan, Doric, Ionic, etc. The book by Nicholas Goldmann, 1662, describing the method of using the scales is exhibited. It is believed that this set of scales is the only one in existence.

SCALES AND WEIGHTS

Money Scales. A large variety of money scales, mostly of the eighteenth century, by English and foreign makers is exhibited.

Guinea Scales. Chiefly of English manufacture. These scales were so named because they were generally carried by Inland Revenue officials for checking the weight of the gold coins submitted to them. *c.* 1800.

Cup Weights. Eight nests of these weights are shown. *c.* 1600–1700.

Steelyards. Italian, iron, 4 ft. long, with travelling weight. Two small iron, and one wooden one, with travelling weights.

MISCELLANEOUS

Scarificator. Or blood-letting instrument, with twelve blades, by Savigny and Co. *c.* 1800.

Medical Chest. *c.* 1800.

Drawing of Auxanometer. Designed and made by Horace Darwin for his brother Francis in 1877. This is believed to be the first instrument he designed.

Trade Card by John Yarwell. Dated 1683. The back is covered by extracts from the Classics in Newton's writing.

PORTRAITS

Engravings of
John Bird.
John Dollond.
Galileo Galilei.
Edmond Halley.
John Harrison.
William M. Herschel.
Benjamin Martin.
Isaac Newton.

Photographs of
H. L. Callendar.
H. Le Chatelier.
W. Duddell.
W. Einthoven.
C. Fèry.
R. T. Glazebrook.
C. Guillaume.
Keith Lucas.

"Spy" Cartoons of
Charles Darwin.
Frank Crisp.
William Thomson (Lord Kelvin).

Engraving by Sebastian le Clerc, of the Academy of Sciences and Fine Arts, Paris. 1698.

BOOK COLLECTION

The collection of books consists of approximately 1500 volumes. A selection will be exhibited, including the following:

First editions of Charles Darwin, including the *Origin of Species*, 1859.

First editions of Robert Boyle, including *The Sceptical Chymist*, 1661.

JOHANNES HEVELIUS. *Machinae Coelestis pars prior Organographiam sive Instrumentorum Astronomicorum Omnium*, etc., 1673.

ISAAC NEWTON. *Philosophiae Naturalis Principia Mathematica*, 1687.
—— Ditto, 2nd Edition, 1713.

WILLIAM GILBERT. *De Magnete*, 1st Edition, 1600.
—— Ditto, 2nd Edition, 1628 (Ben Jonson's autographed copy).
—— Ditto, 3rd Edition, 1633.
—— Silvanus Thompson's translation published by The Gilbert Club, 1900.

ROBERT HOOKE. *Micrographia*. 1st Edition, 1665.
—— Ditto, 2nd Edition, 1667.
—— *Lectiones Cutlerianae*, 1674.

JOHN FLAMSTEED. *Historiae Coelestis*, etc., 1712, with Holograph *S. P. Rigaud.*

GALILEO GALILEI. *Dialogo*, etc., 1632.

FRANCIS BACON. *Novum Organum*, 1620.

EDMUND GUNTER. *The Description and Use of the Sector, the Crosse-staffe and other Instruments*, etc., 1st Edition, 1623.
—— Ditto, 2nd Edition, 1636.

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